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~~Paper for presentation~~ at meeting of
Aeroballistic Range Associ~~ation~~

NASA-Ames Research Center

PARABOLIC ENTRY SIMULATOR AND CATCHER

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Among some of the more recent facilities to be developed at the Ames Research Center is the Parabolic Entry Simulator. This facility consists of a varying density supersonic nozzle driven by a 6-inch diameter shock tube. The interior of this nozzle has been contoured to give the same density variation as that of the earth's atmosphere

i.e, $\frac{\rho}{\rho_o} = e^{-\beta y}$. Models are launched into the high-enthalpy airstream by means of a two-stage shock heated light-gas gun which is capable of firing 1/10 gram models at speeds up to 23,000 feet per second. As the .22 caliber plastic model flies through the simulator nozzle, photomultipliers spaced along the nozzle sense the light increase. These photomultipliers trigger spark gaps to provide pictures at the respective stations and also stop counters for a time-distance history of the model's progress. The photomultipliers are blanked out until the gun is fired to prevent prefiring of the spark gaps due to the light from the starting shock wave.

A unique operation of the simulator is the recovery of the model after its flight through the simulator. A catcher loaded with cold gas is used to slow the model before the model is actually recovered. The need for such a device becomes apparent in view of the fact that the model speed is still around 14,000 feet per second after it has flown the length of the simulator nozzle. Figure 2 is a schematic drawing of the catcher. Physically it can be described as a reservoir of cold gas contained by a quick opening valve and the sponge rubber catcher material.

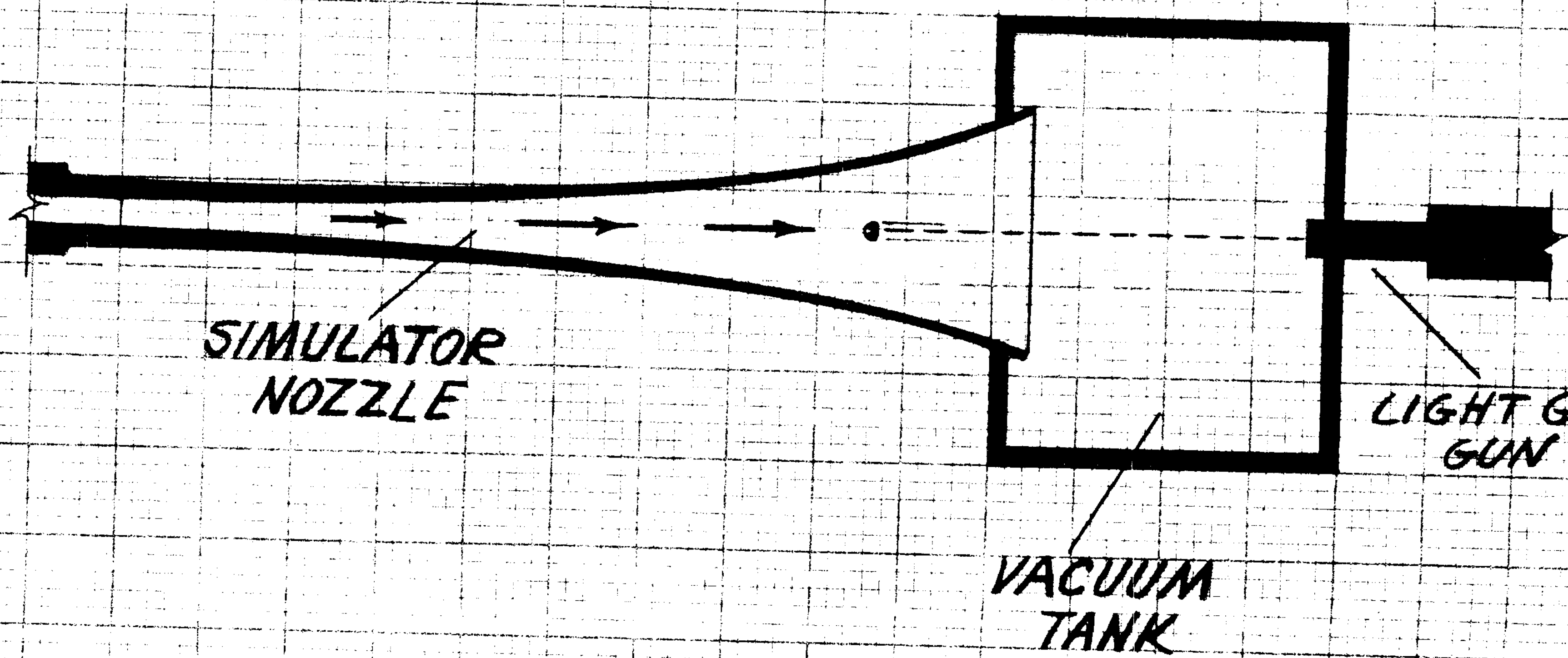
The typical operation of the catcher involves pressurizing the catcher with the desired gas and then compressing the driving spring. The unit is then ready for operation. The shock tube is fired and the high-pressure gas flowing into the simulator reservoir equalizes the pressure across the valve. The spring drives the valve open prior to gun fire and it remains open throughout the remainder of the run. The gun is fired and the model traverses the nozzle, is slowed to a low speed in the catcher and impacts into the sponge rubber to complete model recovery.

The time required for the valve to fully open is approximately 18 msec under actual operating conditions. Figure 3 shows the valve operation under simulated conditions during a bench test. Two microswitches mounted on the mechanism itself indicate the first movement of the valve (first trace deflection) and also the fully opened position (second trace deflection). During early operation, the valve was found to bounce off the fully opened position as indicated by the top trace at approximately 15 msec after reaching the fully opened position. To correct this condition, a small block of styrafoam was placed on the valve driving rod and allowed to be crushed by a stop nut at the end of valve travel. This condition existed during the test corresponding to the second trace. As indicated the valve opened in approximately 10 msec and did not bounce.

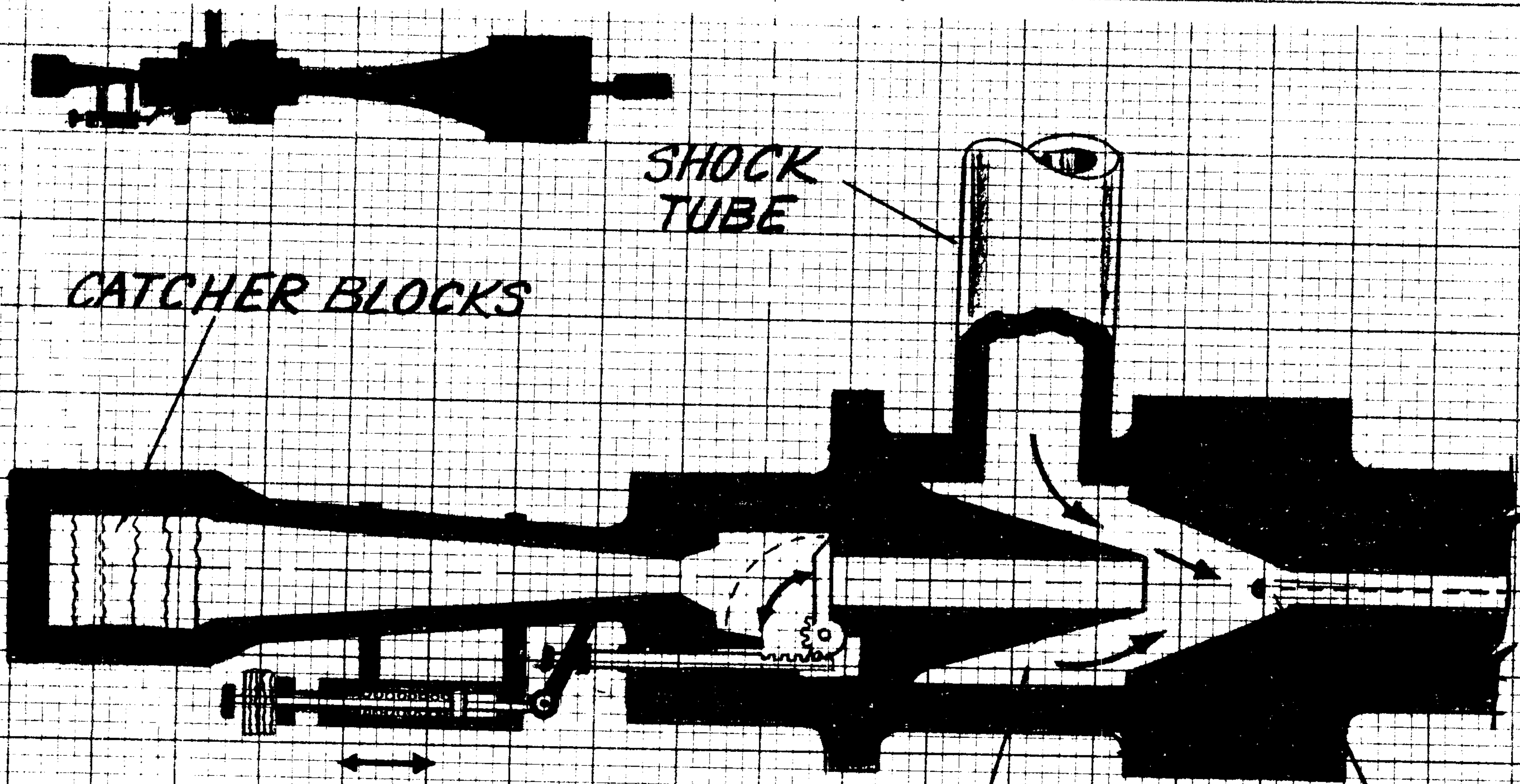
The interior of the catcher is nearly two feet long and nominal gas pressures are 1000 psig. Nitrogen gas has been used in the catcher so that the hot air supplied by the shock tube will not burn the sponge rubber at the end of the catcher. Three one-inch disks of sponge rubber have been used and the model is usually recovered within the first ~~shock.~~ block

The catcher in its present configuration and using the conditions described above has proven to be an effective method for slowing down the models to facilitate model recovery.

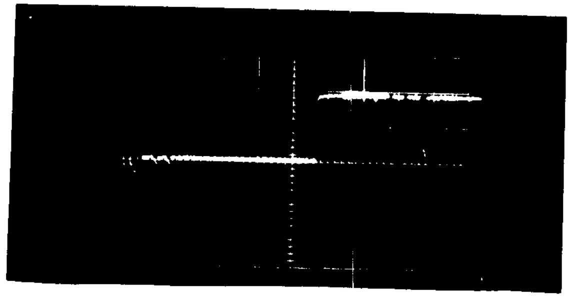
PARABOLIC ENTRY SIMULATOR
SIMULATOR NOZZLE

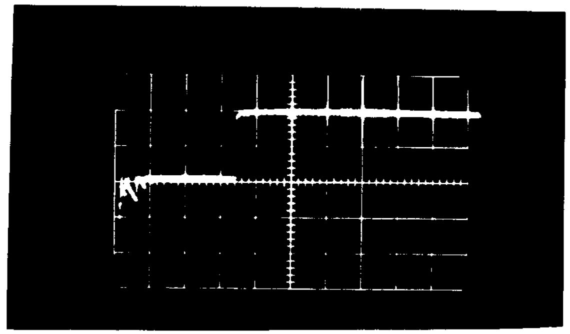


PARABOLIC ENTRY SIMULATOR
MODEL CATCHER



CATCHER VALVE OPERATION





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AEROBALLISTIC RANGE ASSOCIATION

THIRD MEETING

March ~~20 - 21~~ 22-23, 1962

Ames Research Center, NASA.
Moffett Field, Calif.

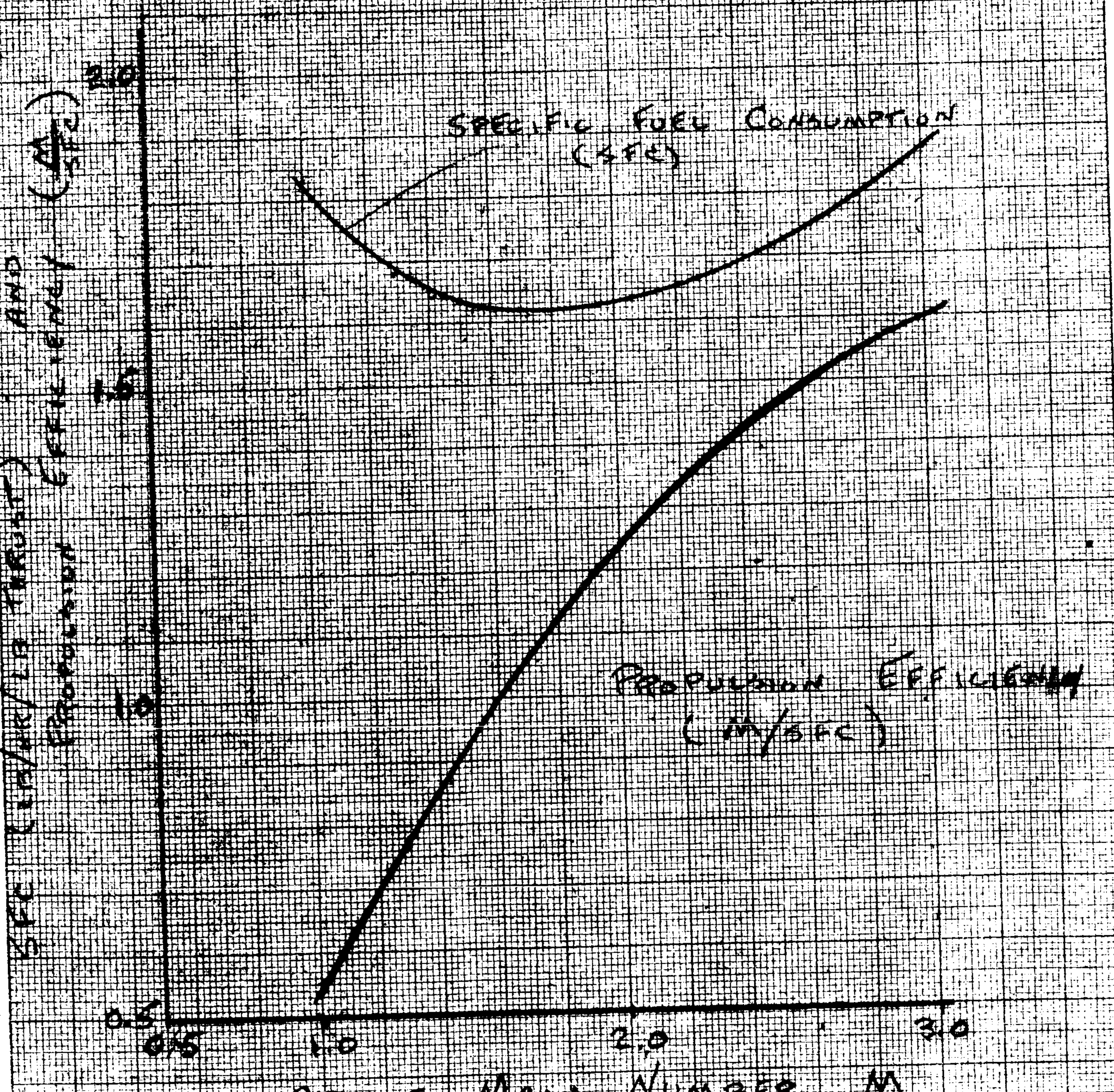
Transcript of a Talk Presented by a Member

of the Ames Research Center Staff

(NOTE: This information is for the use of ARA members only. It is preliminary and subject to review, and is not to be referred to in print.)

FIGURE 1

SPECIFIC FUEL CONSUMPTION AND PROPULSION EFFICIENCY AS FUNCTIONS OF MACH NUMBER



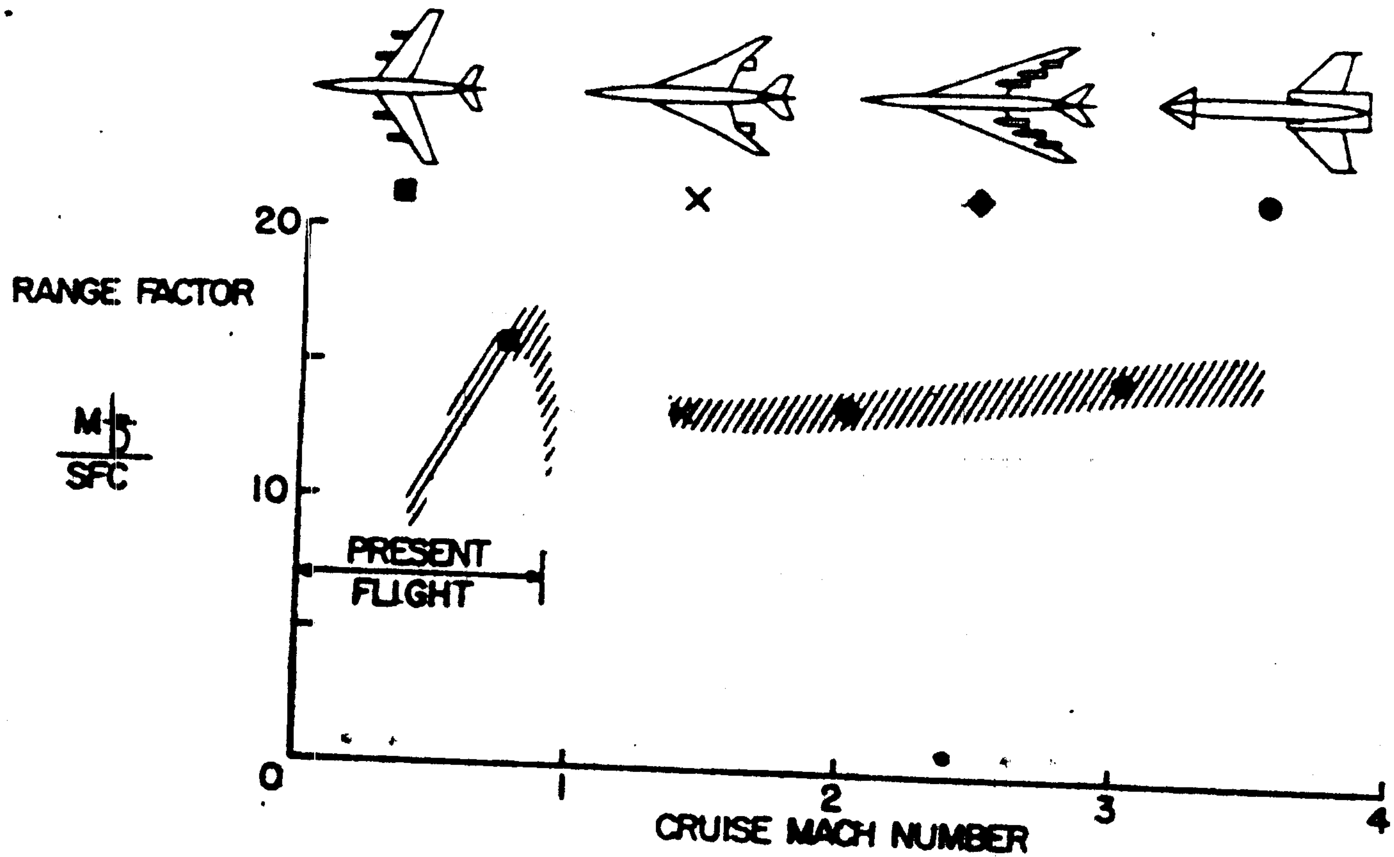


Figure 2 - Jet transport cruise efficiency.

Source: NASA, reference 27

M=3 TRANSPORT

PEAK EXTERNAL SKIN TEMPERATURES, °F

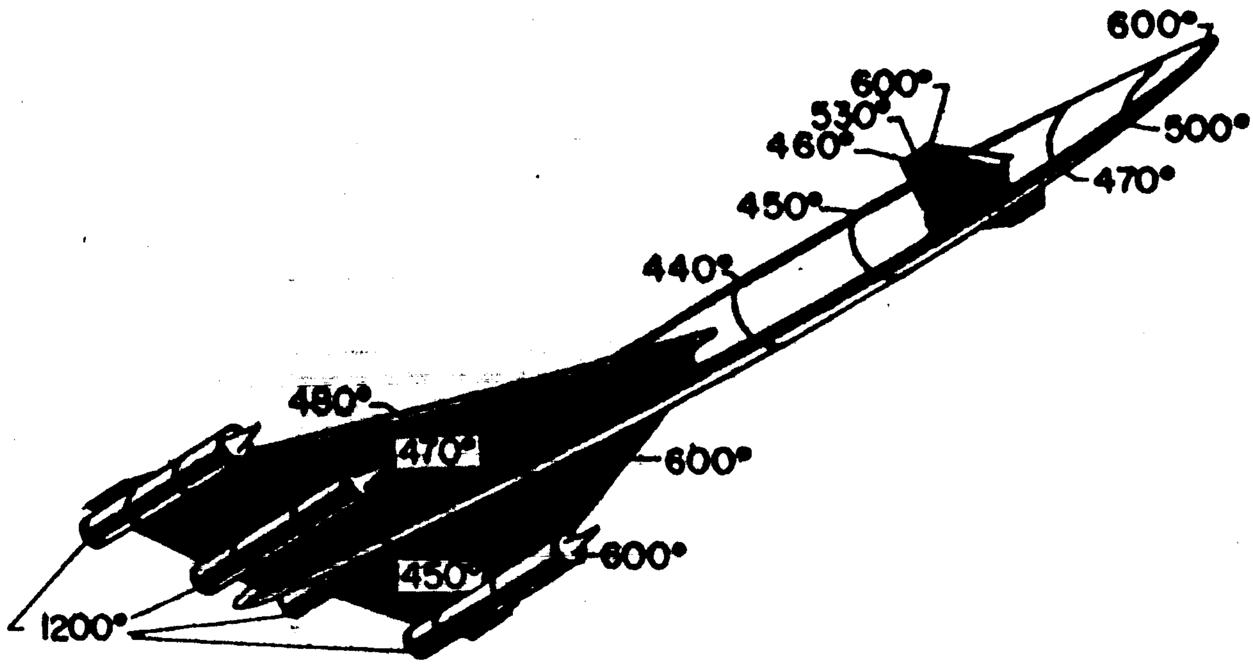


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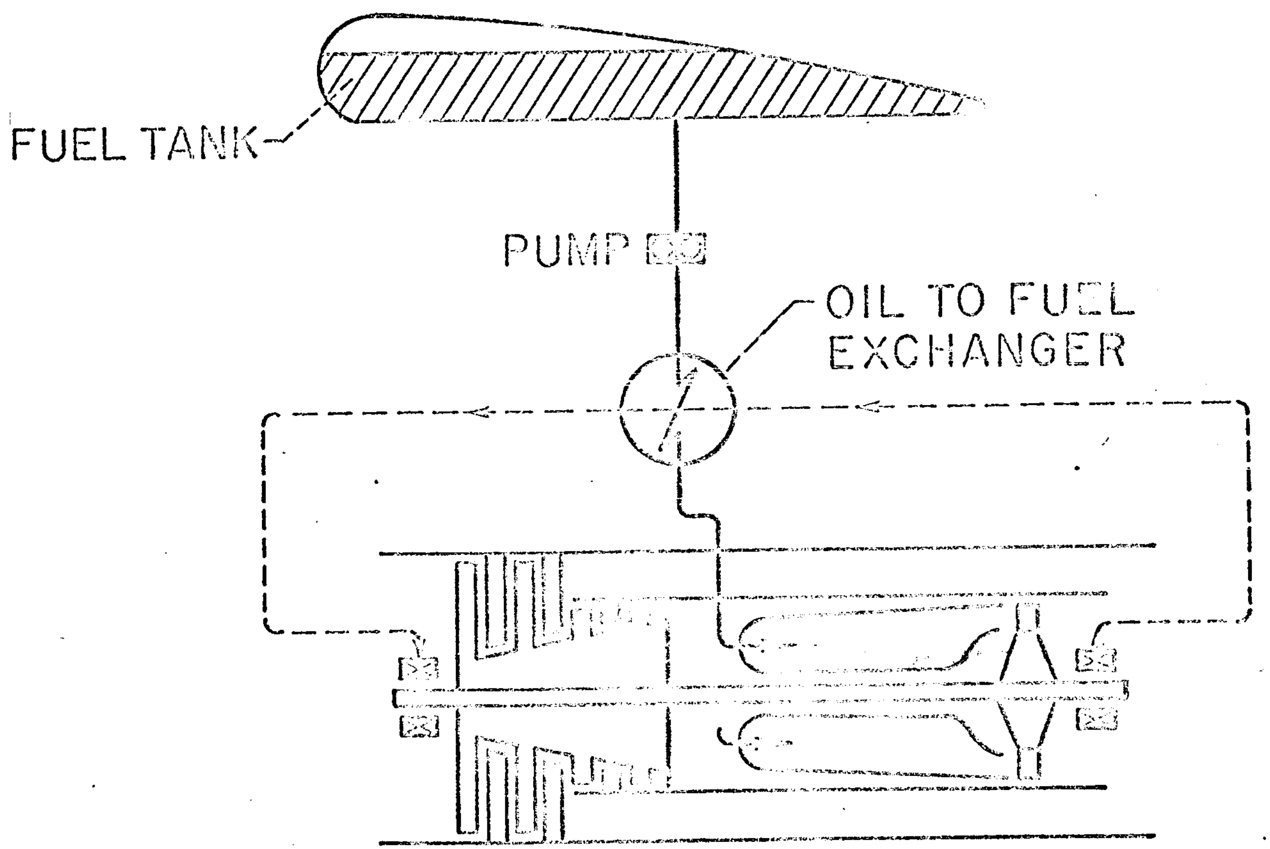
Figure ~~20~~

Source: NASA, reference 78

Figure 4.

CONVENTIONAL TJ



Fk G Figure 5.

DUCT BURNING ~~TJ~~ Turbofan

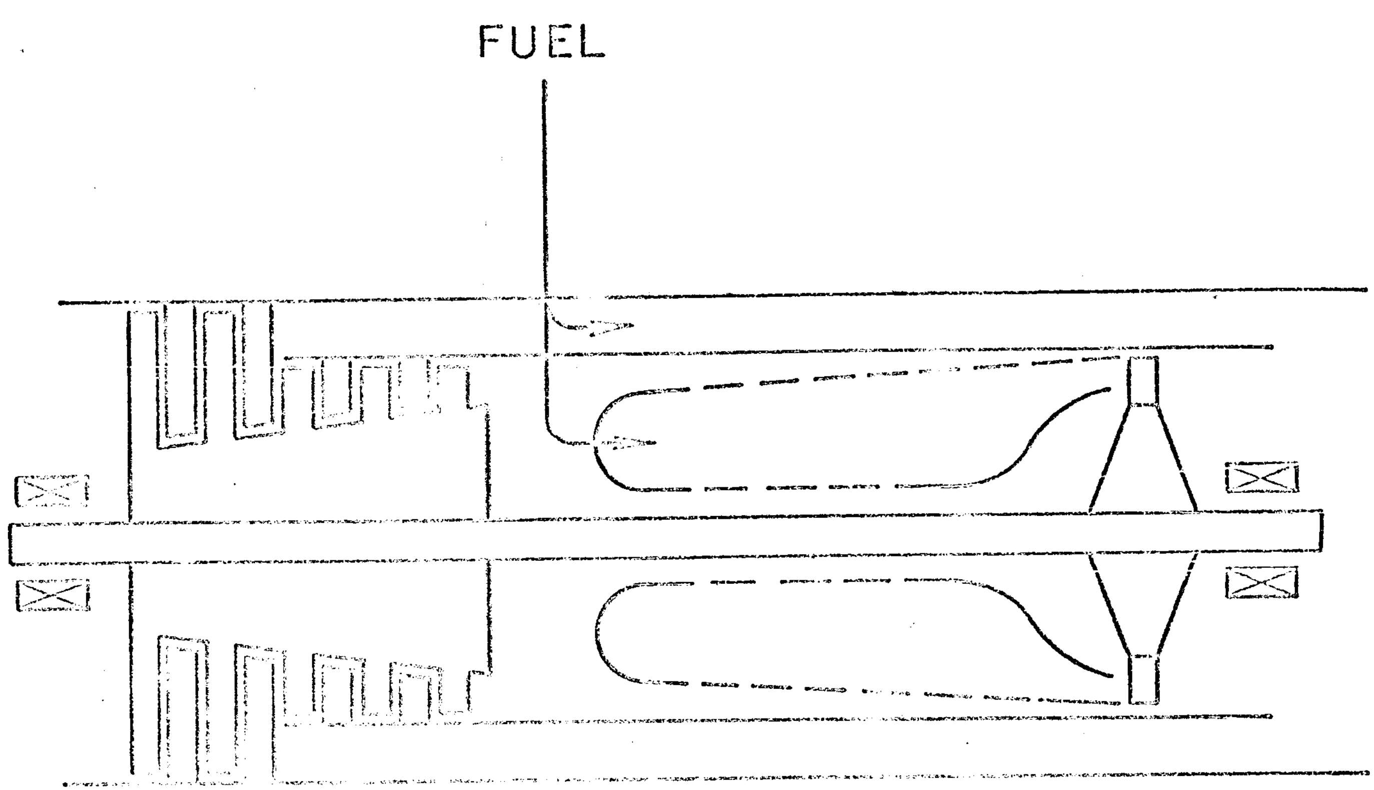


Figure 6.

SST FUEL SYSTEM

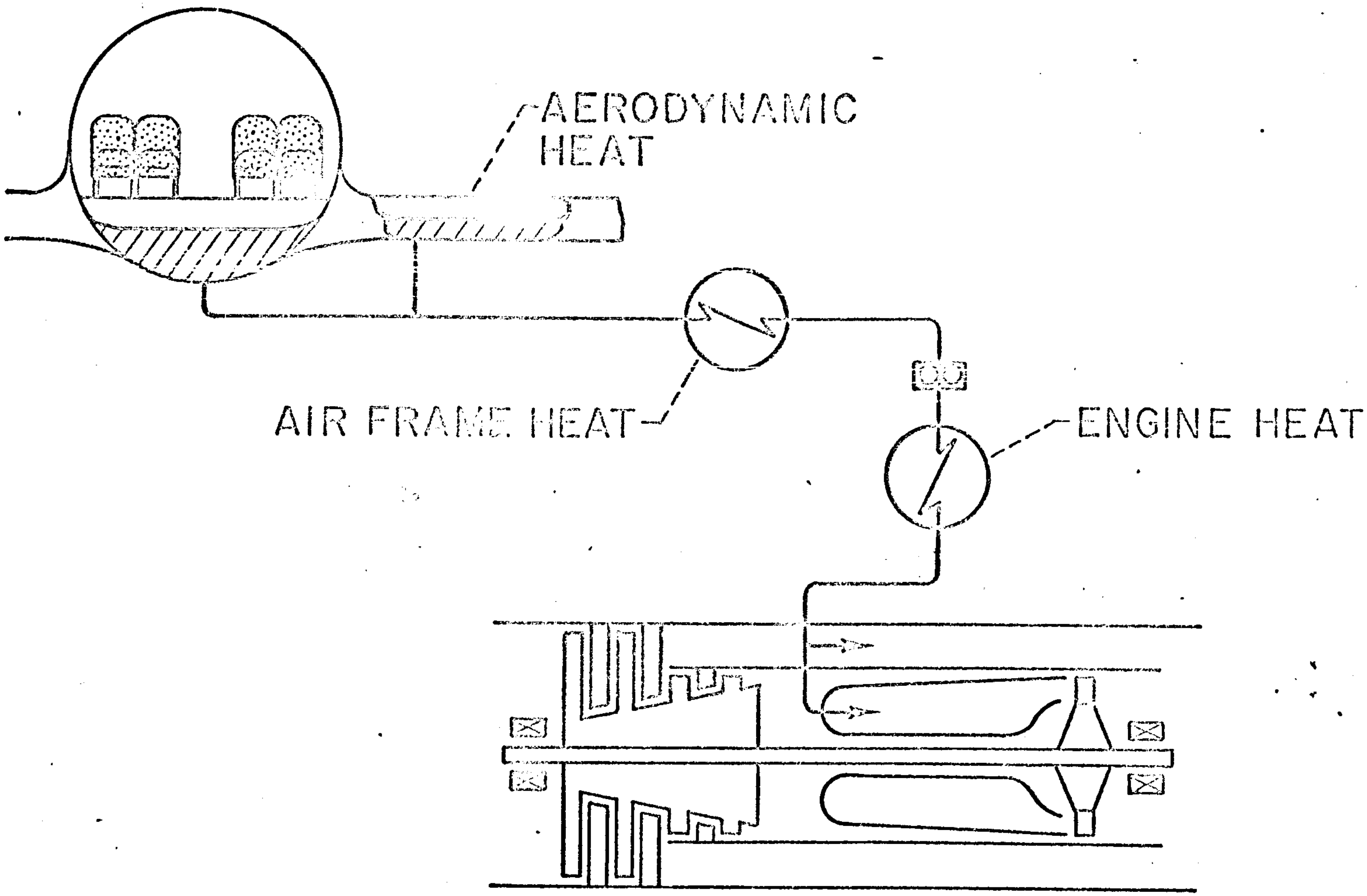
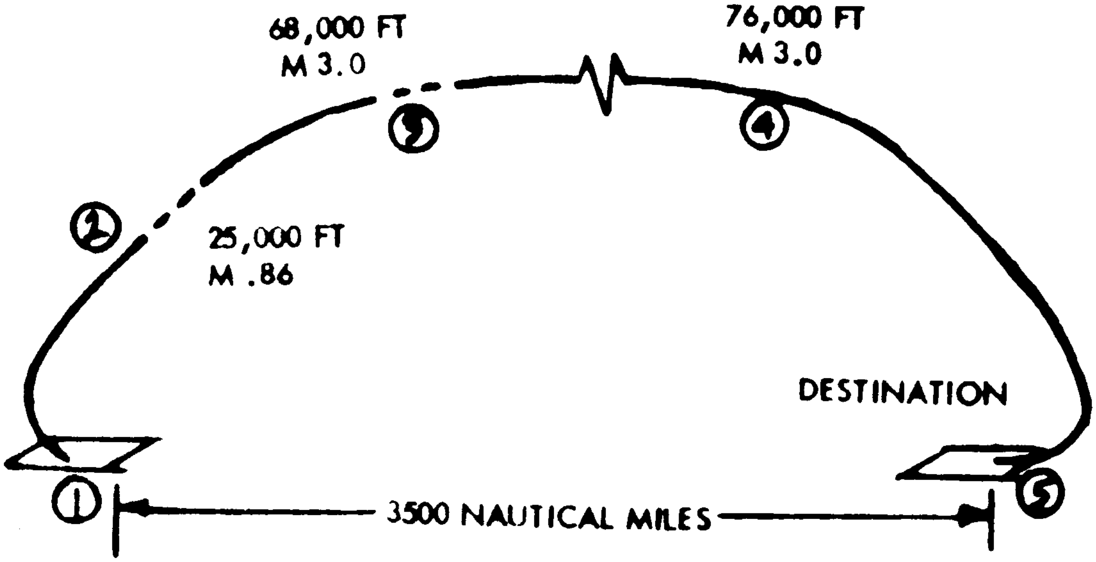


Figure 17

SST MISSION PROFILE
(from reference 19)



OPERATION	FUEL USED (%) INCREMENT	FUEL USED (%) TOTAL	TIME (MIN) INCREMENT	TIME (MIN) TOTAL
1. TAKEOFF	2	2	1	1
2. SUBSONIC CLIMB TO 25,000 FT	6	8	6.5	7.5
3. SUPERSONIC ACCELERATION AND CLIMB TO MACH 3.0 CRUISE ALTITUTDE	18	26	14.5	22
4. CRUISE TO DESTINATION	56	82	104	126
5. DECELERATION AND DESCENT TO SEA LEVEL	3	85	33	159
6. RESERVE	15	100		

Fig 8
(ref 19)

SUPERSONIC TRANSPORT
REPRESENTATIVE FUEL TEMPERATURES

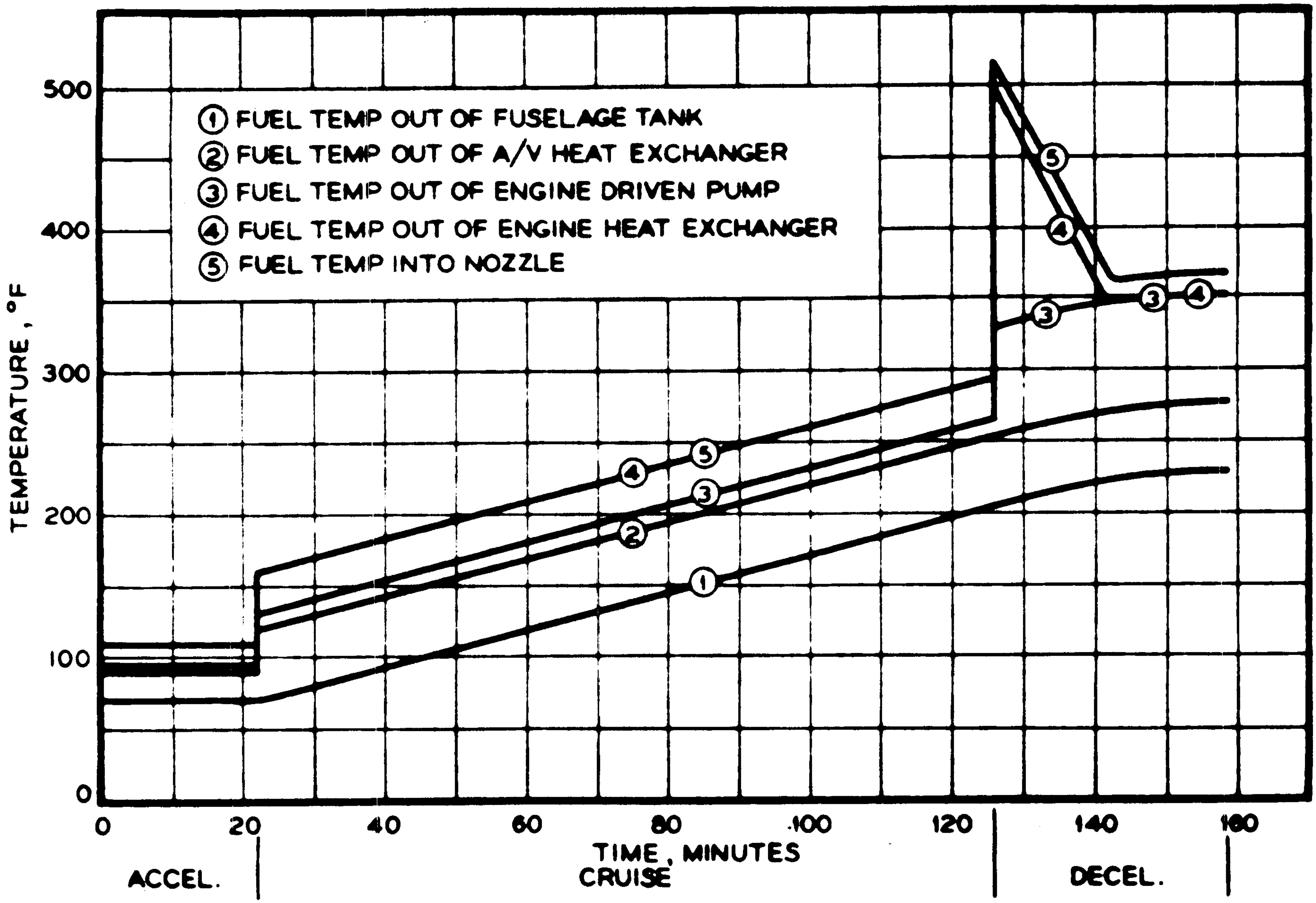


Figure 9.

IMPLICATIONS OF -

(A) 10 MG SOLIDS/GAL

(B) 10,000 GAL/HR, OR
2,500 GAL/HR/ENGINE

(C) 1,000 HR TBO AND 30,000 HR LIFE

(D) FUELS AT $0.05/GAL PREMIUM

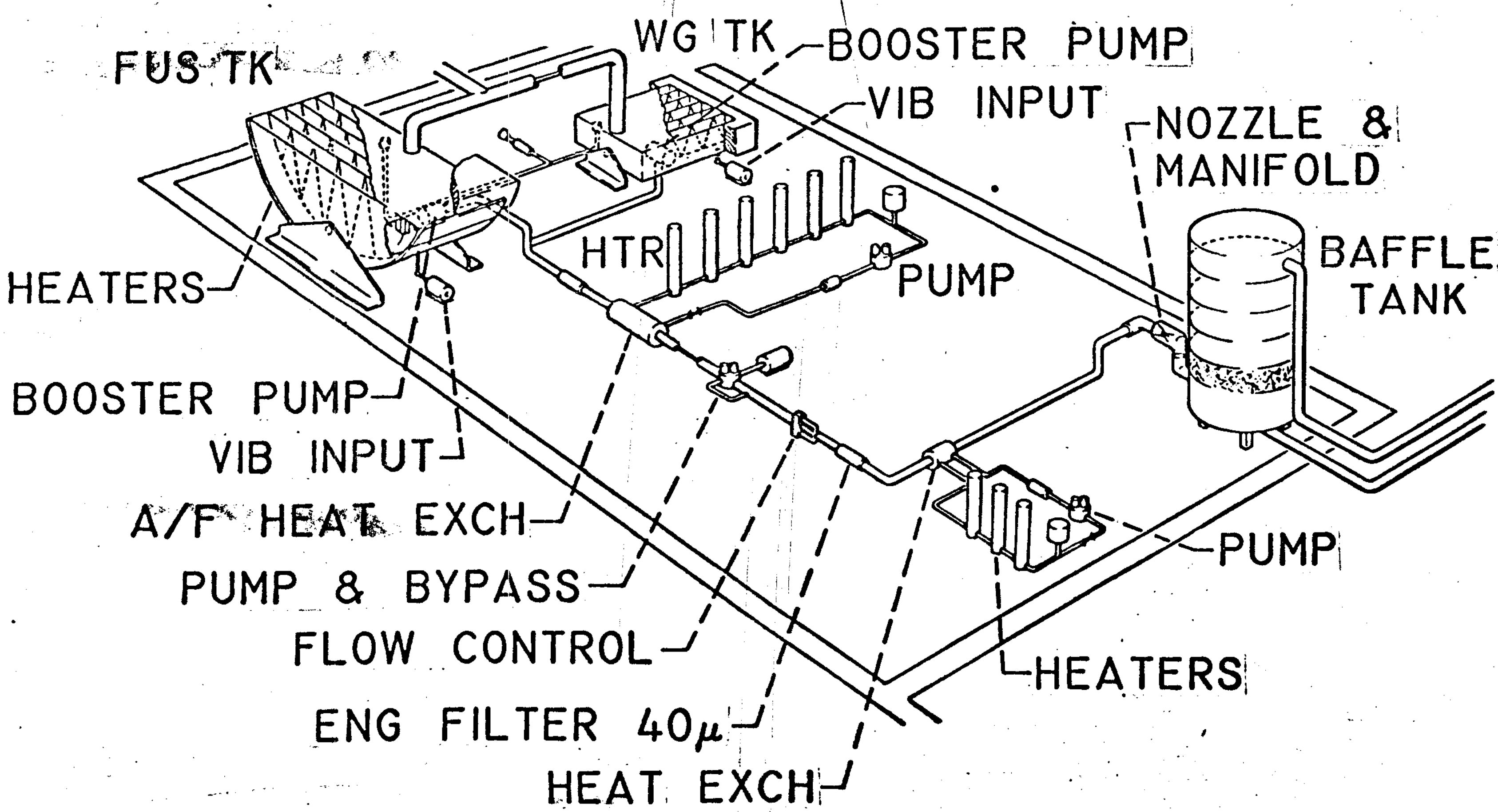
1. TO ENGINE DESIGNER
   = 50 LB GUNK BETWEEN OVERHAULS

2. TO FUEL SUPPLIER
   = 3 PARTS PER MILLION SOLIDS, OR
   0.999997 PURE

3. TO AIRLINE OPERATOR, PREMIUM FUEL
   = $15,000,000 EXTRA COST OVER LIFE
   OF AIRPLANE

Figure 10

COORDINATING RESEARCH COUNCIL SST FUEL SYSTEM TEST RIG



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